Formula of a Hydrate

Introduction

Many ionic compounds incorporate a fixed number of water molecules into their crystal structures. These are called hydratres. Heat can be applied to a hydrated salt to release the H_2O molecules and produce an anhydrous salt which often will appear different than its hydrate. When expressing the formula for a hydrate, it is necessary to notate the fixed number of H_2O molecules following the anhydrous formula for the ionic compound. A large dot is placed between the formula and the H_2O molecules. For example: $CuSO_4 \cdot 5H_2O$ is the correct formula for the hydratred form of copper sulfate. In this activity, you will be determining the number of H_2O molecules in the hydrate of either alum (aluminum potassium sulfate: $AlK(SO_4)_2$) or Epsom salts (magnesium sulfate: $MgSO_4$).

Materials

(Alum)
- evaporating dish
- wire gauze
- alum ~1 tablespoon

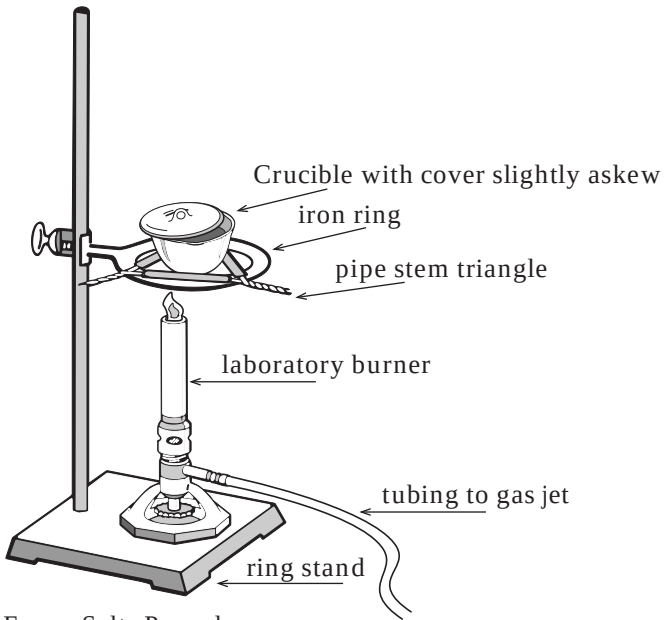
(Epsom salts)
- crucible and cover
- pipe stem triangle
- Epsom salts ~1/2 teaspoon

(Both)
- crucible tongs
- balance
- ring stand
- iron ring
- laboratory burner
- burner lighter
- goggles

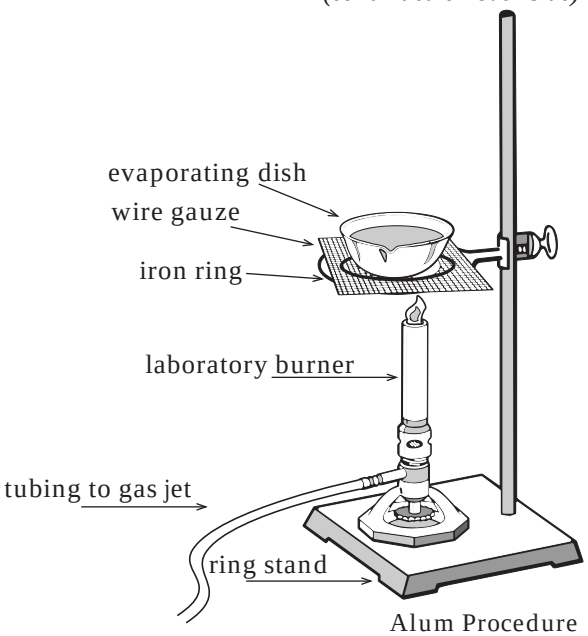
Procedure

1. Put on your goggles. Secure iron ring on ring stand a couple of inches above the height of the burner. Place wire gauze (alum) or triangle (Epsom salts) on iron ring.
2. Place clean evaporating dish or crucible and cover on gauze or triangle. Light burner and heat for a couple of minutes to make certain container is thoroughly dry. Turn off burner and cool container for several minutes until it is comfortable to touch. Record the mass of the dry evaporating dish (alum) or crucible and cover (Epsom salts).
3. Add about a tablespoon of alum to the evaporating dish if that is the hydrate assigned to you. If your assigned hydrate is Epsom salts, add about ½ teaspoon and cover the crucible. Record the mass of the container with the hydrate.
4. Place the container back on the gauze/triangle (cover should be slightly ajar) and heat gently with hot flame until the water has been released from the hydrate. This will require about 5 minutes. *(see illustrations below)*

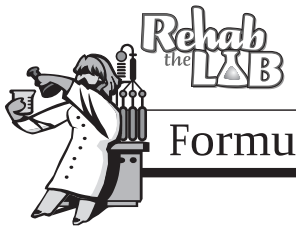
(continued on back side)



Epson Salts Procedure



Alum Procedure



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Procedure *(continued from front side)*

5. When no more H_2O appears to be coming from the hydrate, turn off the burner and cool for several minutes until container is comfortable to the touch.
6. Record the mass of the container (and cover if using Epsom salts) with anhydrous salt.
7. If time allows, reheat the container with salt, cool and remass. If the two final masses agree, you can be confident that you have indeed released all of the H_2O from the hydrate.
8. Clean up as directed by your teacher and wash your hands.

Data Table

Hydrate assigned to you:

Alum

a.	Mass of Evaporating Dish	g
b.	Mass of Dish and Hydrate	g
c.	Mass of Dish and Anhydrous Salt	g

Epson Salts

a.	Mass of Crucible and Cover	g
b.	Mass of Crucible, Cover, & Hydrate	g
c.	Mass of Crucible, Cover & Anhydrous Salt	g

Analysis and Calculations

1. Calculate the mass of the anhydrous salt:

_____g

2. Find the molar mass of anhydrous alum ($AlK(SO_4)_2$) or Epsom salts ($MgSO_4$):

_____g

3. Calculate the moles of anhydrous salt:

_____moles

4. Calculate the mass of H_2O “cooked out” of your hydrate:

_____g

5. Find the molar mass of H_2O:

_____g

6. Calculate the moles of H_2O released:

_____moles

7. Divide the moles H_2O by the moles of anhydrous salt to determine the ratio of moles of H_2O to moles of anhydrous salt. Round to the nearest small whole number.

_____

8. Write the correct formula for your hydrate:_____•_____H_2O.

9. Using the correct formula, calculate the percent of H_2O in your hydrate.